

High-velocity resistance training mitigates physiological and functional impairments in middle-aged and older adults with and without mobility-limitation.

GeroScience

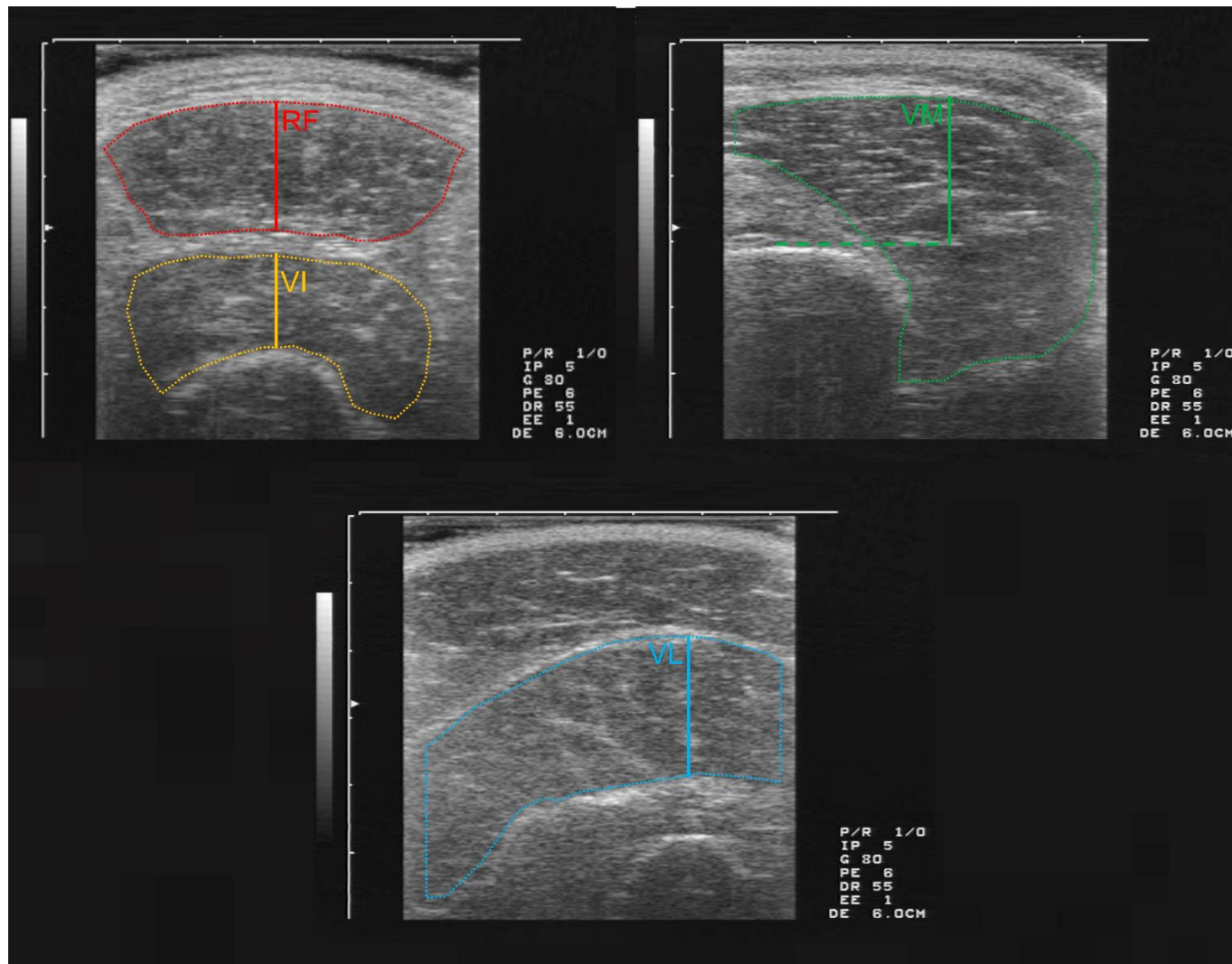
Gustavo Z. Schaun^{1,2*}, Marcos M. Bamman^{2,3}, Luana S. Andrade¹, Gabriela B. David¹, Vitor L. Krüger¹, Eduardo F. Marins¹, Gabriela N. Nunes¹, Mariana S. Häfele¹, Graciele F. Mendes¹, Maria Laura B. Gomes¹, Paula C. Campelo¹; Stephanie S. Pinto¹, Cristine L. Alberton¹

¹Neuromuscular Assessment Laboratory, Physical Education School, Federal University of Pelotas, Pelotas, RS, Brazil.

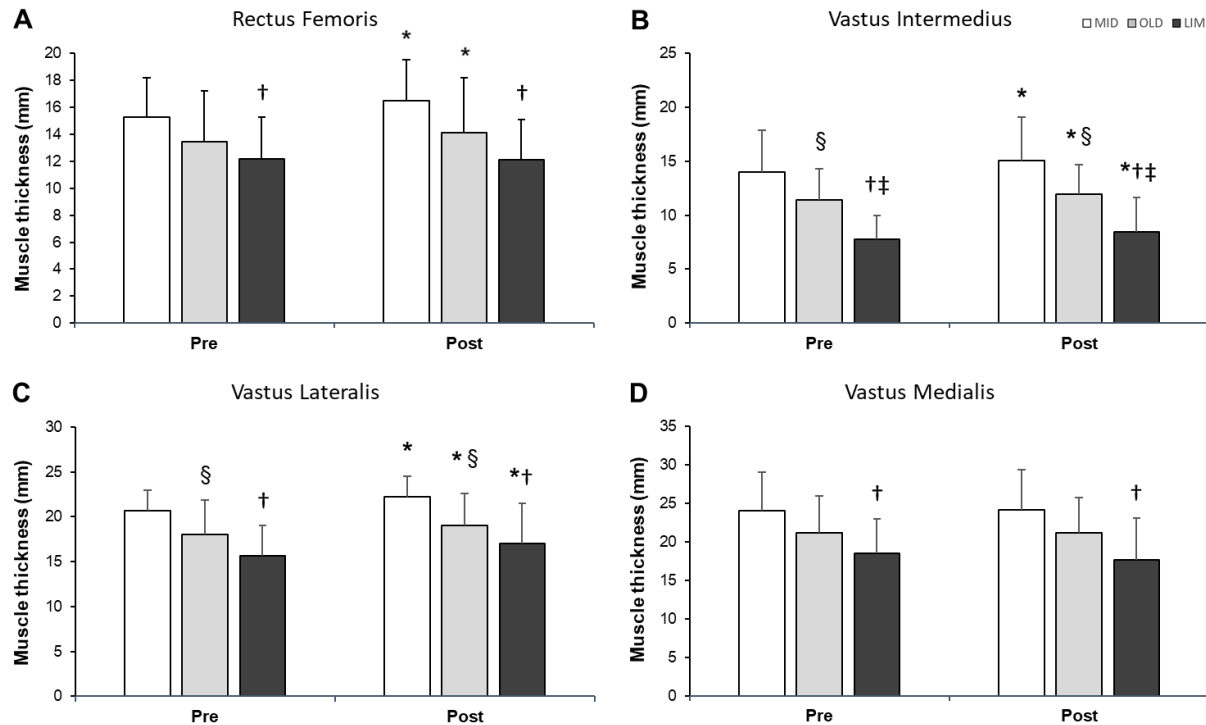
²UAB Center for Exercise Medicine, University of Alabama at Birmingham, Birmingham, AL.

³Florida Institute for Human and Machine Cognition, Pensacola, FL.

*Corresponding author: gustavoschaun@hotmail.com

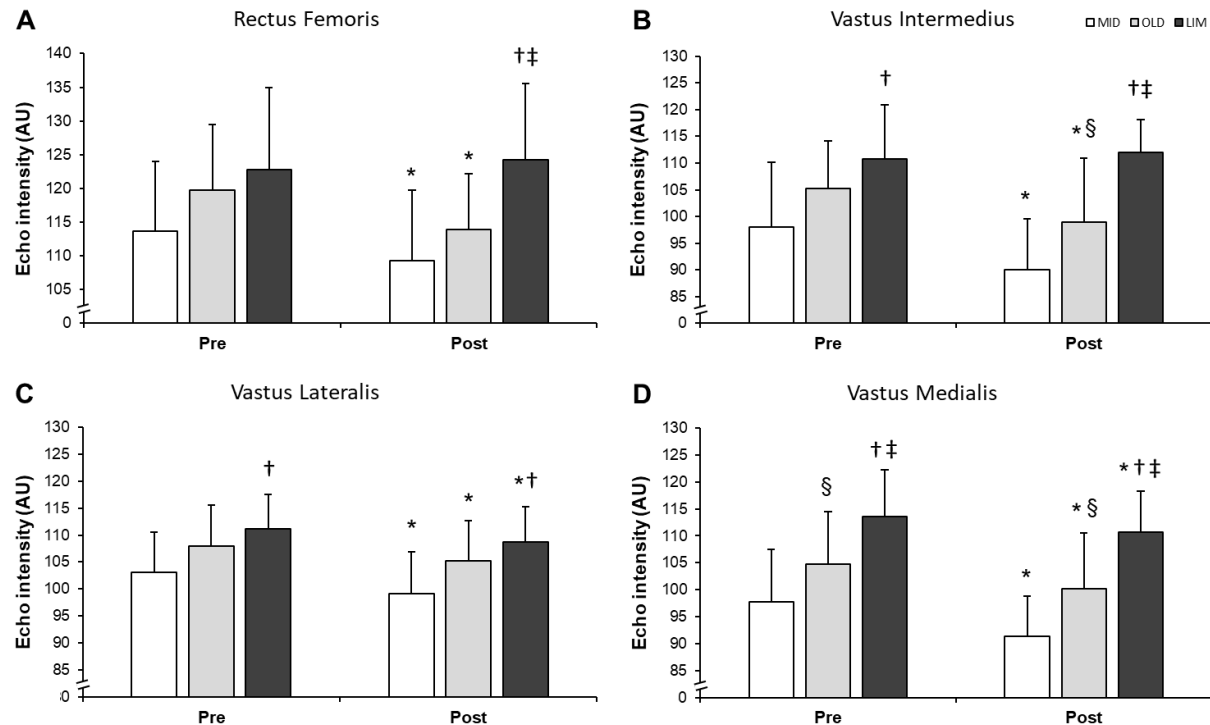


Supplementary Figure 1. Representative ultrasound images of the individual quadriceps muscles analysed. RF = *rectus femoris*; VI = *vastus intermedius*; VM = *vastus medialis*; VL = *vastus lateralis*. Note: continuous lines represent muscle thickness measures, whereas dotted lines represent the area used for echo intensity determination. In all images, the hyperechoic interface of the femur was used as a reference point for muscle thickness determination. For a detailed explanation of how the measures were obtained, readers are referred to Section 2.3.



Supplementary Figure 2. Quadriceps muscle thickness responses to 12 weeks of high-velocity resistance training in middle-aged (MID), older (OLD) and mobility-limited older (LIM) participants. Results are presented separately for each muscle (A-D). * = Post greater than Pre (all $p < 0.05$); † = LIM lower than MID (all $p < 0.05$); ‡ = LIM lower than OLD (all $p < 0.05$); § = OLD lower than MID (all $p < 0.05$). Values are (mean \pm SD).

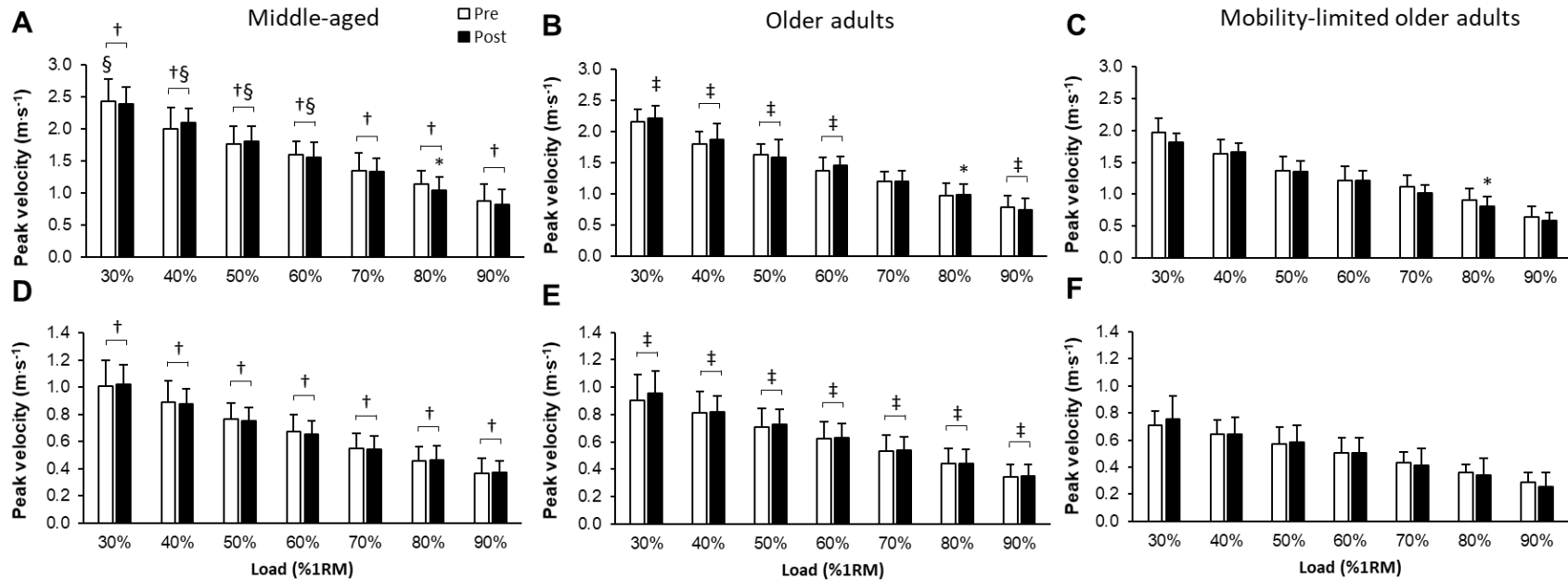
When results were analyzed separately for each muscle, an increase in RF muscle thickness was observed in middle-aged ($p < 0.001$) and older adults ($p < 0.001$), but not in the mobility-limited participants ($p = 0.776$), the latter of which was found to be lower compared to middle-aged adults both pre ($p = 0.028$) and post ($p = 0.001$) training. For the VI and VL muscles, thickness increased in all three groups ($p < 0.001$) and was found to be greater in middle-aged adults compared to both mobility-limited (both $p < 0.001$) and older adults (both $p < 0.001$). VL muscle thickness was also found to be greater in older than mobility-limited older adults ($p = 0.003$). No improvements were noted for VM ($p = 0.446$), which differed only between middle-aged and mobility-limited older individuals ($p = 0.007$).



Supplementary Figure 3. Quadriceps echo intensity responses to 12 weeks of high-velocity resistance training in middle-aged (MID), older (OLD) and mobility-limited older (LIM) participants. Results are presented separately for each muscle (A-D). * = Post greater than Pre (all $p < 0.05$); † = LIM lower than MID (all $p < 0.05$); ‡ = LIM lower than OLD (all $p < 0.05$); § = OLD lower than MID (all $p < 0.05$). Values are (mean \pm SD).

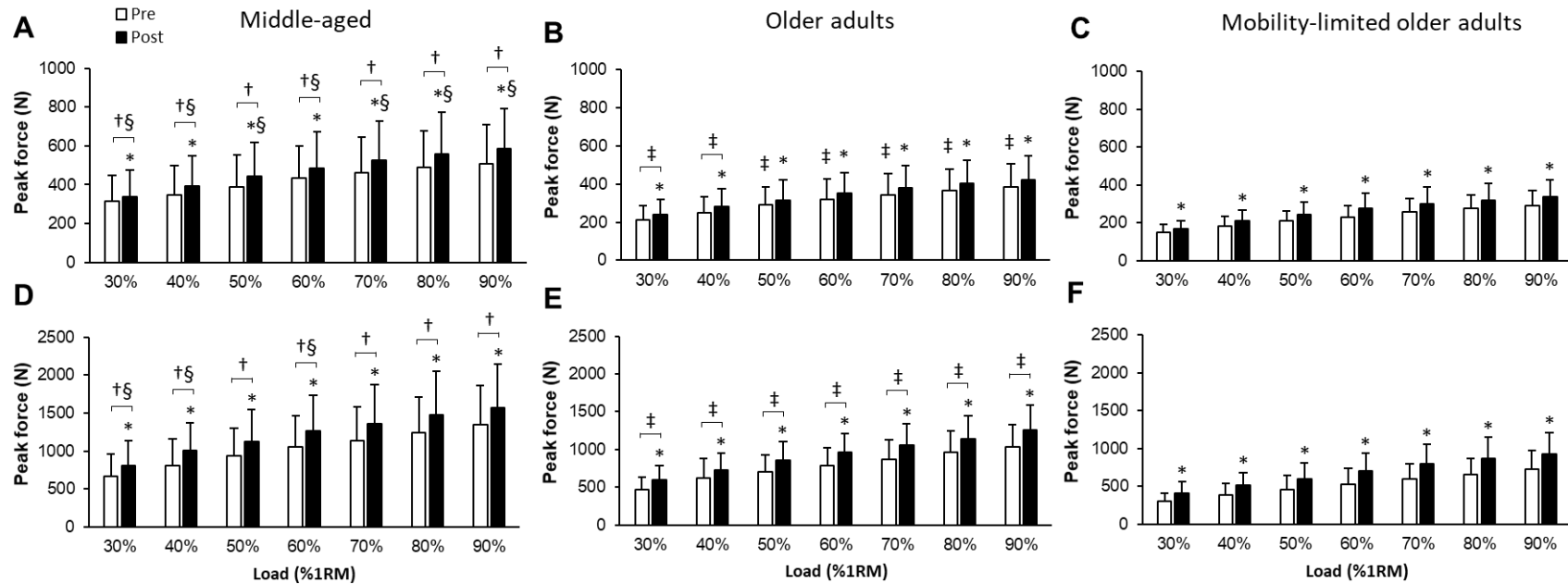
Similar to quadriceps results, reductions in both RF and VI echo intensity signals were observed in the middle-aged (both $p < 0.001$) and older participants ($p < 0.001$ and $p = 0.001$, respectively), but not in the mobility-limited group ($p = 0.539$ and $p = 0.708$). On the other hand, VL and VM echo intensity signals reduced after training in all three groups ($p < 0.001$). Regarding group differences, RF echo intensity did not differ between the groups pre-training, but middle-aged ($p = 0.003$) and older adults ($p = 0.045$) values were lower than mobility-limited older participants post-training. VI differed only between middle-aged and mobility-limited older adults at pre-training ($p = 0.012$) but was found to be different between all groups after the intervention ($p < 0.001$ between mobility-limited older adults and the other groups and $p = 0.033$ between middle-aged and older adults). Further, no differences were found between middle-aged and older adults ($p = 0.056$) and older adults and mobility-limited older adults ($p = 0.604$) for the VL muscle, but middle-aged individuals had a lower echo intensity value than the latter ($p = 0.002$). Finally, VM differed between the three groups both pre- and post-training ($p < 0.001$ between mobility-limited older adults and middle-aged adults; $p = 0.014$ between mobility-limited older adults and older adults; and $p = 0.015$ between middle-aged and older adults).

***Power test performed using 1RM workloads relative to post-training 1RM measures.**



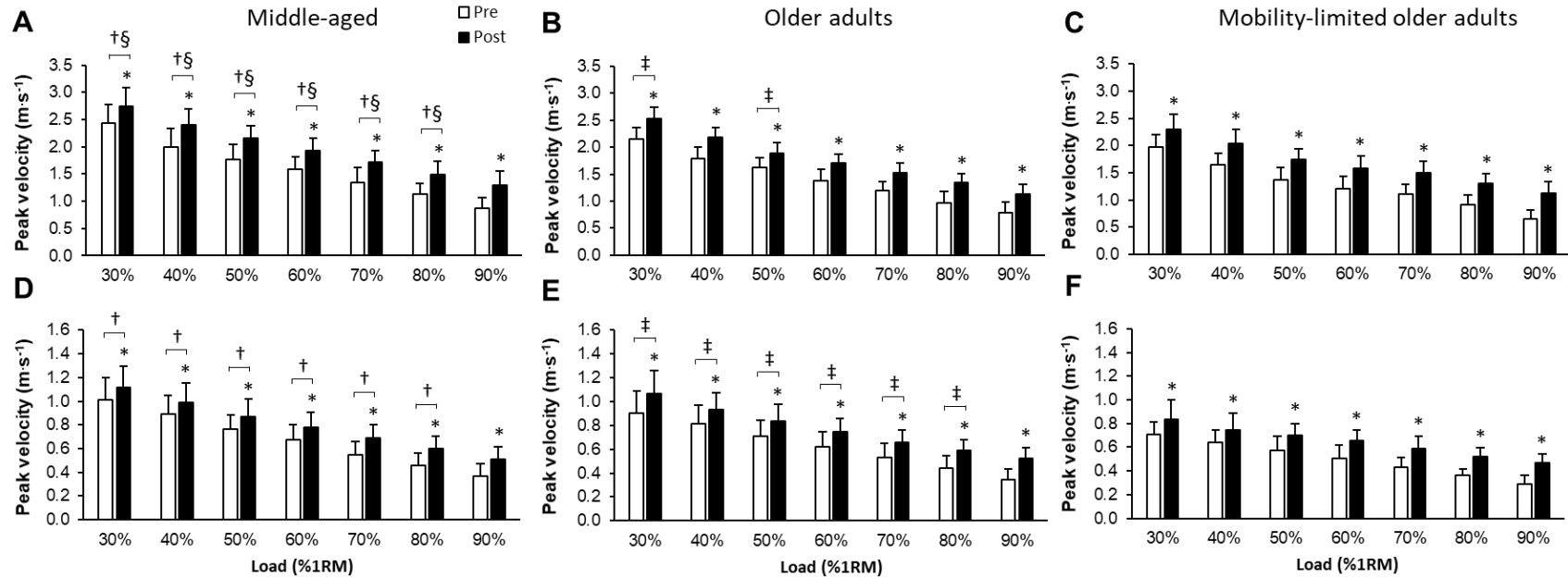
Supplementary Figure 4. Knee extension (A-C) and Leg press (D-F) **peak velocity** responses to 12 weeks of high-velocity resistance training in middle-aged (A, D), older (B, E) and mobility-limited older (C, F) participants based on 1RM **at the time of testing**. * = greater than Pre ($p < 0.05$); † = middle-aged adults greater than mobility-limited older adults ($p < 0.05$); ‡ = older adults greater than mobility-limited older adults ($p < 0.05$); § = middle-aged adults greater than older adults ($p < 0.05$).

***Power test performed using 1RM workloads relative to post-training 1RM measures.**



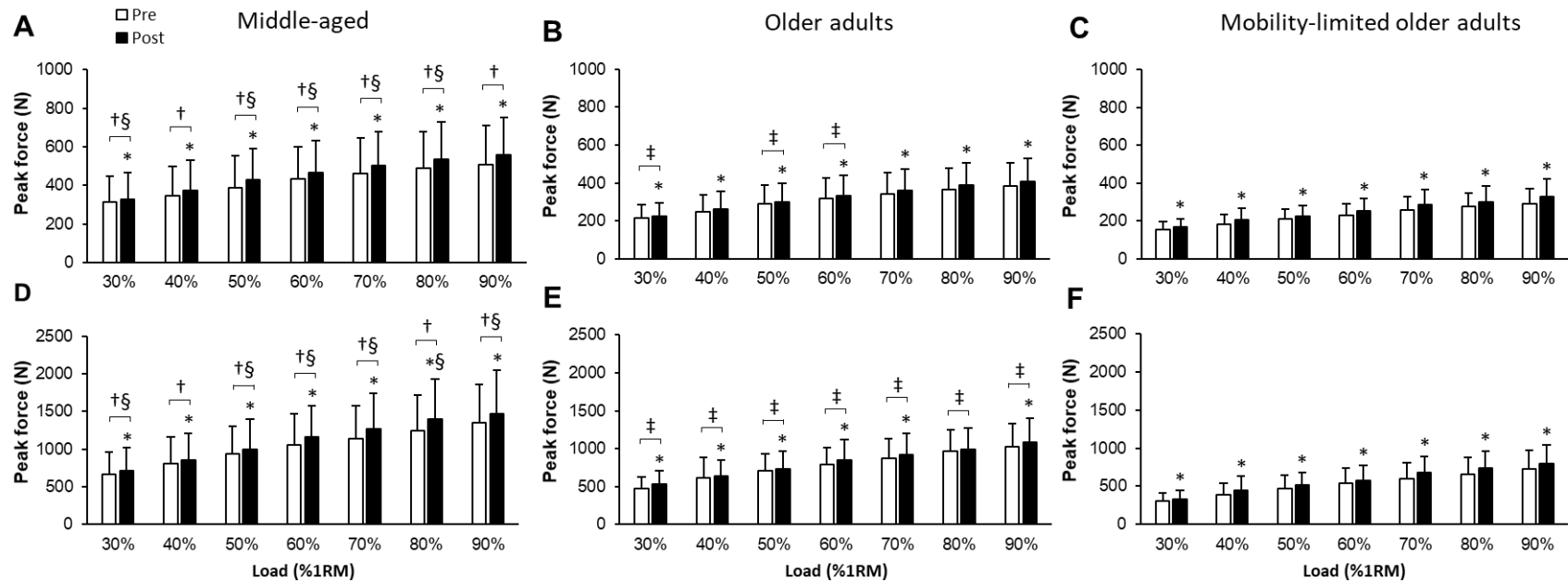
Supplementary Figure 5. Knee extension (A-C) and Leg press (D-F) **peak force** responses to 12 weeks of high-velocity resistance training in middle-aged (A, D), older (B, E) and mobility-limited older (C, F) participants based on 1RM **at the time of testing**. * = greater than Pre ($p < 0.05$); † = middle-aged adults greater than mobility-limited older adults ($p < 0.05$); ‡ = older adults greater than mobility-limited older adults ($p < 0.05$); § = middle-aged adults greater than older adults ($p < 0.05$).

***Power test performed using 1RM workloads relative to pre-training 1RM measures.**



Supplementary Figure 6. Knee extension (A-C) and Leg press (D-F) **peak velocity** responses to 12 weeks of high-velocity resistance training in middle-aged (A, D), older (B, E) and mobility-limited older (C, F) participants based on **pre-intervention** 1RM loads. * = greater than Pre ($p < 0.05$); † = middle-aged adults greater than mobility-limited older adults ($p < 0.05$); ‡ = older adults greater than mobility-limited older adults ($p < 0.05$); § = middle-aged adults greater than older adults ($p < 0.05$).

***Power test performed using 1RM workloads relative to pre-training 1RM measures.**



Supplementary Figure 7. Knee extension (A-C) and Leg press (D-F) **peak force** responses to 12 weeks of high-velocity resistance training in middle-aged (A, D), older (B, E) and mobility-limited older (C, F) participants based on **pre-intervention** 1RM loads. * = greater than Pre ($p < 0.05$); † = middle-aged adults greater than mobility-limited older adults ($p < 0.05$); ‡ = older adults greater than mobility-limited older adults ($p < 0.05$); § = middle-aged adults greater than older adults ($p < 0.05$).

Supplementary Table 1. Comparison between baseline (wk -4) and pre-intervention (wk 0) time points among the groups investigated.

	<i>Middle-aged adults (n=17)</i>		<i>Older adults (n=18)</i>		<i>Mobility-limited older adults (n=8)</i>	
	Baseline	Pre	Baseline	Pre	Baseline	Pre
<i>Dynamic strength</i>						
LP 1RM (kg)	183.7 ± 74.4	189.1 ± 68.9*	139.2 ± 40.7	145.0 ± 40.0*	95.6 ± 32.6	104.0 ± 35.2*
KE 1RM (kg)	45.0 ± 16.4	46.2 ± 18.0*	35.9 ± 10.9	37.1 ± 11.2*	27.3 ± 7.4	27.5 ± 7.3*
<i>Isometric strength</i>						
MVIC (kgf)	33.6 ± 13.7	33.9 ± 13.0	26.1 ± 9.0	27.0 ± 9.8	20.0 ± 8.3	20.0 ± 6.5
VL sEMG (µV)	379.3 ± 273.6	395.4 ± 290.6	255.4 ± 98.4	284.8 ± 102.5	293.3 ± 254.2	210.0 ± 67.9
RF sEMG (µV)	259.1 ± 170.7	290.6 ± 231.0	172.3 ± 83.8	219.4 ± 82.0	210.1 ± 154.9	180.9 ± 84.4
BF sEMG (µV)	72.3 ± 36.0	74.6 ± 38.5	52.5 ± 20.3	54.0 ± 17.7	57.1 ± 39.4	43.8 ± 13.4
<i>Ultrasound measures</i>						
RF MT (mm)	15.4 ± 2.9	15.2 ± 2.9	13.4 ± 4.1	13.4 ± 3.8	12.4 ± 3.0	12.2 ± 3.1
VI MT (mm)	14.1 ± 3.4	13.9 ± 3.9	11.4 ± 3.1	11.4 ± 2.9	8.1 ± 2.2	7.8 ± 2.2
VL MT (mm)	20.9 ± 1.9	20.7 ± 2.2	17.9 ± 3.8	18.0 ± 3.9	16.0 ± 4.0	15.7 ± 3.4
VM MT (mm)	24.1 ± 4.7	23.9 ± 5.1	19.6 ± 5.1	21.2 ± 4.8	18.2 ± 5.2	18.5 ± 4.5
QUAD MT (mm)	74.4 ± 11.2	73.6 ± 11.9	62.2 ± 14.0	64.0 ± 13.2*	54.6 ± 12.1	54.1 ± 10.9
RF EI (a.u)	110.6 ± 10.4	114.1 ± 10.4*	118.5 ± 8.8	119.7 ± 9.8	126.6 ± 10.8	122.8 ± 12.2
VI EI (a.u)	95.5 ± 11.9	99.1 ± 12.2	103.2 ± 11.3	105.2 ± 9.0	113.3 ± 7.11	110.8 ± 10.2
VL EI (a.u)	102.7 ± 6.6	103.2 ± 7.3	106.8 ± 7.1	108.0 ± 7.5	111.8 ± 8.5	111.1 ± 6.4
VM EI (a.u)	94.1 ± 6.5	97.9 ± 9.7*	100.8 ± 9.2	104.8 ± 9.7*	114.6 ± 7.3	113.6 ± 8.7*
QUAD EI (a.u)	100.7 ± 7.0	103.5 ± 7.9	107.3 ± 6.7	109.4 ± 7.0	116.5 ± 5.6	114.5 ± 6.5
<i>Functional capacity</i>						
SPPB (points)	11.8 ± 0.5	12.0 ± 0.1	11.5 ± 0.7	11.4 ± 0.7	8.1 ± 1.0	7.9 ± 1.1
30STS (reps)	17.3 ± 2.3	18.7 ± 3.5*	14.4 ± 2.5	14.8 ± 3.3*	10.6 ± 1.9	11.3 ± 2.1*
HGS (m·s ⁻¹)	1.57 ± 0.24	1.54 ± 0.16	1.37 ± 0.19	1.36 ± 0.16	1.23 ± 0.14	1.23 ± 0.14
MGS (m·s ⁻¹)	2.24 ± 0.28	2.19 ± 0.38	1.94 ± 0.31	1.97 ± 0.40	1.62 ± 0.28	1.56 ± 0.21
TUG (s)	5.50 ± 0.73	5.42 ± 0.63	6.55 ± 0.76	6.37 ± 0.85	8.79 ± 1.75	8.94 ± 1.92
SC (s)	4.01 ± 0.55	4.12 ± 0.45	4.71 ± 0.65	4.58 ± 0.49	6.89 ± 1.73	7.04 ± 1.66
TC6 (m)	656.2 ± 61.8	651.3 ± 67.6	547.1 ± 56.7	553.0 ± 58.3	469.9 ± 75.4	441.2 ± 74.9
<i>LP Peak Power</i>						
PP 30% (W)	564.3 ± 331.5	582.7 ± 325.9	355.9 ± 198.4	364.9 ± 181.9	164.0 ± 69.12	186.2 ± 84.2

PP 40% (W)	594.4 ± 316.8	603.4 ± 332.7	398.0 ± 191.0	410.4 ± 196.1	189.0 ± 78.4	220.3 ± 121.7
PP 50% (W)	605.1 ± 290.1	625.1 ± 332.0*	403.0 ± 170.2	425.1 ± 195.2*	198.6 ± 93.6	242.0 ± 146.9*
PP 60% (W)	595.6 ± 306.8	635.9 ± 322.9	404.8 ± 159.2	430.8 ± 192.9	231.0 ± 98.0	250.3 ± 156.2
PP 70% (W)	533.8 ± 288.9	582.4 ± 302.7*	394.0 ± 140.9	418.9 ± 185.4*	208.6 ± 78.9	248.6 ± 127.1*
PP 80% (W)	477.2 ± 255.0	533.0 ± 267.3	345.7 ± 122.3	381.2 ± 166.5	226.4 ± 116.3	218.6 ± 98.7
PP 90% (W)	385.0 ± 204.7	487.1 ± 291.6*	284.9 ± 103.2	327.6 ± 141.4	204.1 ± 100.9	192.3 ± 88.0

KE Peak Power

PP 30% (W)	518.1 ± 245.1	559.0 ± 301.1*	314.3 ± 138.2	338.1 ± 134.1*	190.3 ± 35.3	214.9 ± 78.4*
PP 40% (W)	520.2 ± 271.6	535.9 ± 314.2	321.3 ± 140.7	339.1 ± 148.3	222.4 ± 64.4	223.9 ± 85.0
PP 50% (W)	543.8 ± 275.2	550.7 ± 313.9	348.0 ± 156.9	368.4 ± 148.8	207.3 ± 57.1	218.7 ± 77.0
PP 60% (W)	546.5 ± 243.8	551.9 ± 277.7	345.4 ± 153.6	355.8 ± 161.1	220.6 ± 75.1	223.9 ± 86.9
PP 70% (W)	516.0 ± 252.3	523.1 ± 260.7	330.1 ± 132.3	345.0 ± 133.9	222.3 ± 83.6	234.9 ± 95.0
PP 80% (W)	453.9 ± 222.9	477.0 ± 238.9	299.7 ± 138.8	309.7 ± 126.1	220.7 ± 60.6	213.8 ± 91.2
PP 90% (W)	408.2 ± 237.9	401.4 ± 227.8	280.6 ± 174.4	274.0 ± 119.7	187.0 ± 65.2	165.2 ± 71.3

LP = *leg press*; KE = *knee extension*; 1RM = *one repetition maximum*; RF = *rectus femoris*; VI = *vastus intermedius*; VL = *vastus lateralis*; VM = *vastus medialis*; MT = *muscle thickness*; EI = *echo intensity*. * = different from baseline ($p < 0.05$). Note: for clarity, only differences between time points are shown.

Supplementary Table 2. Percent change and effect size results relative to the 12-wk HVRT intervention.

	Middle-aged adults			Older adults			Mobility-limited older adults		
	Δ%	Cohen's d		Δ%	Cohen's d		Δ%	Cohen's d	
Dynamic strength									
LP 1RM	19.1 ± 6.8	0.48	small	24.2 ± 8.4	0.80	large	32.9 ± 13.6	0.87	large
KE 1RM	17.7 ± 6.4	0.46	small	12.6 ± 7.9	0.39	small	20.8 ± 9.0	0.75	moderate
Isometric strength									
MVIC	8.3 ± 10.7	0.23	small	4.7 ± 9.1	0.10	-	15.0 ± 11.6	0.41	small
VL sEMG	8.9 ± 24.2	0.10	-	4.6 ± 23.2	0.15	-	9.8 ± 25.4	0.24	small
RF sEMG	27.1 ± 46.3	0.20	small	4.2 ± 17.9	0.13	-	-0.4 ± 18.6	0.09	-
BF sEMG	6.3 ± 33.3	0.10	-	27.3 ± 43.0	0.55	moderate	-7.0 ± 22.0	-0.11	-
Ultrasound measures									
RF MT	7.5 ± 6.1	0.36	small	4.9 ± 6.0	0.45	small	-0.5 ± 9.4	-0.02	-
VI MT	8.8 ± 9.5	0.31	small	5.3 ± 10.2	0.19	-	7.1 ± 14.7	0.18	-
VL MT	7.2 ± 4.0	0.70	moderate	6.9 ± 7.9	0.31	small	8.0 ± 8.4	0.25	small
VM MT	0.8 ± 6.8	0.03	-	1.0 ± 11.5	0.01	-	-4.9 ± 11.4	-0.13	-
QUAD MT	5.2 ± 3.5	0.34	small	4.2 ± 5.6	0.19	-	1.6 ± 8.7	0.07	-
RF EI	-3.7 ± 4.0	0.44	small	-4.6 ± 3.6	0.81	large	1.4 ± 6.1	-0.09	-
VI EI	-8.0 ± 7.4	0.84	large	-6.0 ± 7.6	0.76	moderate	1.7 ± 9.5	-0.10	-
VL EI	-3.8 ± 3.9	0.57	moderate	-2.5 ± 4.3	0.51	moderate	-2.1 ± 3.7	0.28	small
VM EI	-6.4 ± 5.5	0.81	large	-4.3 ± 6.3	0.64	moderate	-2.4 ± 3.5	0.26	small
QUAD EI	-5.4 ± 4.2	0.84	large	-4.3 ± 4.5	0.52	moderate	-0.5 ± 3.9	0.08	-
Functional capacity									
SPPB	-0.5 ± 2.0	-0.35	-	4.8 ± 7.5	0.97	large	38.6 ± 22.8	2.55	v. large
30STS	10.3 ± 14.3	0.52	moderate	6.9 ± 6.1	0.30	small	20.6 ± 15.8	1.10	large
HGS	-0.7 ± 7.4	-0.09	-	5.2 ± 10.7	0.45	small	2.5 ± 4.6	0.24	small
MGS	4.2 ± 8.5	0.23	small	3.6 ± 7.5	0.16	-	5.6 ± 12.2	0.40	small
TUG	-8.5 ± 10.0	0.91	large	-0.9 ± 11.2	0.11	-	-8.1 ± 12.4	0.51	moderate
SC	-11.8 ± 8.6	1.09	large	-6.4 ± 7.0	0.57	moderate	-12.7 ± 8.2	0.58	moderate
TC6	1.0 ± 3.6	0.10	-	1.4 ± 4.8	0.12	-	4.5 ± 11.8	0.24	small
LP Power 1RM post									
PP 30%	23.3 ± 23.7	0.33	small	39.4 ± 25.8	0.63	moderate	47.4 ± 30.2	0.74	moderate

PP 40%	22.5 ± 26.6	0.32	small	29.6 ± 18.8	0.50	moderate	35.6 ± 25.7	0.50	moderate
PP 50%	20.4 ± 19.7	0.30	small	31.9 ± 16.7	0.57	moderate	36.2 ± 25.4	0.46	small
PP 60%	17.5 ± 21.2	0.27	small	29.4 ± 17.6	0.53	moderate	34.4 ± 22.0	0.43	small
PP 70%	21.2 ± 27.9	0.31	small	28.4 ± 22.7	0.51	moderate	20.3 ± 19.3	0.36	small
PP 80%	26.9 ± 42.5	0.40	small	30.1 ± 39.3	0.47	small	21.8 ± 33.2	0.45	small
PP 90%	25.7 ± 35.9	0.26	small	32.5 ± 30.8	0.56	moderate	17.8 ± 37.3	0.31	small

LP Power 1RM pre

PP 30%	22.1 ± 19.6	0.34	small	35.0 ± 29.9	0.56	moderate	29.8 ± 23.8	0.54	moderate
PP 40%	24.3 ± 27.1	0.38	small	23.9 ± 17.0	0.41	small	24.6 ± 19.1	0.40	small
PP 50%	24.4 ± 21.3	0.39	small	28.7 ± 16.7	0.52	moderate	31.3 ± 23.7	0.40	small
PP 60%	26.0 ± 20.3	0.43	small	29.6 ± 15.9	0.55	moderate	43.5 ± 25.8	0.46	small
PP 70%	39.4 ± 23.6	0.59	moderate	33.8 ± 25.1	0.61	moderate	47.0 ± 14.7	0.61	moderate
PP 80%	45.9 ± 34.3	0.68	moderate	47.4 ± 32.8	0.82	large	47.6 ± 13.6	0.85	large
PP 90%	57.4 ± 43.2	0.65	large	66.8 ± 40.2	1.08	large	78.9 ± 38.7	1.19	large

KE Power 1RM post

PP 30%	12.0 ± 15.7	0.18	-	20.1 ± 14.4	0.43	small	10.4 ± 21.5	0.21	small
PP 40%	28.4 ± 33.7	0.34	small	21.6 ± 20.6	0.43	small	23.1 ± 18.5	0.51	moderate
PP 50%	23.0 ± 22.4	0.29	small	9.6 ± 12.9	0.24	small	24.0 ± 23.3	0.54	moderate
PP 60%	13.3 ± 14.1	0.23	small	23.6 ± 27.8	0.37	small	24.8 ± 28.5	0.50	moderate
PP 70%	16.6 ± 17.3	0.24	small	13.7 ± 20	0.28	small	10.1 ± 16.5	0.20	small
PP 80%	7.7 ± 13.9	0.11	-	21.5 ± 43.7	0.28	small	8.8 ± 21.6	0.14	-
PP 90%	16.0 ± 37.2	0.12	-	12.7 ± 41.6	0.12	-	21.8 ± 50.8	0.18	-

KE Power 1RM pre

PP 30%	22.6 ± 22.9	0.34	small	26.2 ± 20.1	0.62	moderate	28.4 ± 26.8	0.99	large
PP 40%	35.1 ± 39	0.45	small	29.6 ± 17.8	0.60	moderate	37.6 ± 10.4	1.17	large
PP 50%	37.3 ± 25.1	0.50	moderate	22.6 ± 17.8	0.51	moderate	39.8 ± 18.8	1.33	v. large
PP 60%	33.7 ± 20.7	0.57	moderate	32.5 ± 29.7	0.57	moderate	41.6 ± 22.0	1.29	large
PP 70%	41.0 ± 32.1	0.64	moderate	21.1 ± 25.5	0.69	moderate	46.1 ± 24.0	1.20	large
PP 80%	42.5 ± 23.2	0.70	moderate	51.3 ± 60.8	0.89	large	62.3 ± 28.1	1.46	v. large
PP 90%	67.2 ± 49.7	0.88	large	53.4 ± 47.8	0.90	large	92.4 ± 38.0	1.93	v. large

LP = leg press; KE = knee extension; 1RM = one repetition maximum; RF = rectus femoris; VI = vastus intermedius; VL = vastus lateralis; VM = vastus medialis; MT = muscle thickness; EI = echo intensity. Note: Cohen's d values were classified as suggested by Sullivan & Feinn (2012): 0.2 = small; 0.5 = moderate; 0.8 = large; 1.3 = very large. Values are mean ± SD.

Supplementary Table 3. Percent change and between-group effect size results.

	Δ%			Cohen's d					
	MID	OLD	LIM	MID vs. OLD		MID vs. LIM		OLD vs. LIM	
<i>Dynamic strength</i>									
LP 1RM	19.1 ± 6.8	24.2 ± 8.4	32.9 ± 13.6	0.67	moderate	1.28	large	0.77	moderate
KE 1RM	17.7 ± 6.4	12.6 ± 7.9	20.8 ± 9.0	0.71	moderate	0.4	small	0.97	large
<i>Isometric strength</i>									
MVIC	8.3 ± 10.7	4.7 ± 9.1	15.0 ± 11.6	0.36	small	0.6	moderate	0.99	large
VL sEMG	8.9 ± 24.2	4.6 ± 23.2	9.8 ± 25.4	0.18	-	0.04	-	0.21	small
RF sEMG	27.1 ± 46.3	4.2 ± 17.9	-0.4 ± 18.6	0.66	moderate	0.78	moderate	0.25	small
BF sEMG	6.3 ± 33.3	27.3 ± 43.0	-7.0 ± 22.0	0.54	moderate	0.47	small	1	large
<i>Ultrasound measures</i>									
RF MT	7.5 ± 6.1	4.9 ± 6.0	-0.5 ± 9.4	0.43	small	1.01	large	0.69	moderate
VI MT	8.8 ± 9.5	5.3 ± 10.2	7.1 ± 14.7	0.36	small	0.14	-	0.14	-
VL MT	7.2 ± 4.0	6.9 ± 7.9	8.0 ± 8.4	0.05	-	0.12	-	0.14	-
VM MT	0.8 ± 6.8	1.0 ± 11.5	-4.9 ± 11.4	0.02	-	0.6	moderate	0.52	moderate
QUAD MT	5.2 ± 3.5	4.2 ± 5.6	1.6 ± 8.7	0.21	small	0.54	moderate	0.36	small
RF EI	-3.7 ± 4.0	-4.6 ± 3.6	1.4 ± 6.1	0.24	small	0.99	large	1.2	large
VI EI	-8.0 ± 7.4	-6.0 ± 7.6	1.7 ± 9.5	0.27	small	1.14	large	0.90	large
VL EI	-3.8 ± 3.9	-2.5 ± 4.3	-2.1 ± 3.7	0.32	small	0.45	small	0.10	-
VM EI	-6.4 ± 5.5	-4.3 ± 6.3	-2.4 ± 3.5	0.36	small	0.87	large	0.37	small
QUAD EI	-5.4 ± 4.2	-4.3 ± 4.5	-0.5 ± 3.9	0.25	small	1.16	large	0.90	large
<i>Functional capacity</i>									
SPPB	-0.5 ± 2.0	4.8 ± 7.5	38.6 ± 22.8	0.97	large	2.42	v. large	1.99	v. large
30STS	10.3 ± 14.3	6.9 ± 6.1	20.6 ± 15.8	0.31	small	0.68	moderate	1.14	large
HGS	-0.7 ± 7.4	5.2 ± 10.7	2.5 ± 4.6	0.64	moderate	0.52	moderate	0.33	small
MGS	4.2 ± 8.5	3.6 ± 7.5	5.6 ± 12.2	0.07	-	0.13	-	0.2	small
TUG	-8.5 ± 10.0	-0.9 ± 11.2	-8.1 ± 12.4	0.72	moderate	0.04	-	0.61	moderate
SC	-11.8 ± 8.6	-6.4 ± 7.0	-12.7 ± 8.2	0.69	moderate	0.11	-	0.83	moderate
TC6	1.0 ± 3.6	1.4 ± 4.8	4.5 ± 11.8	0.09	-	0.4	small	0.34	small
<i>LP Power 1RM post</i>									
PP 30%	23.3 ± 23.7	39.4 ± 25.8	47.4 ± 30.2	0.65	moderate	0.89	large	0.29	small
PP 40%	22.5 ± 26.6	29.6 ± 18.8	35.6 ± 25.7	0.31	small	0.5	moderate	0.27	small

PP 50%	20.4 ± 19.7	31.9 ± 16.7	36.2 ± 25.4	0.63	moderate	0.7	moderate	0.2	small
PP 60%	17.5 ± 21.2	29.4 ± 17.6	34.4 ± 22.0	0.61	moderate	0.78	moderate	0.25	small
PP 70%	21.2 ± 27.9	28.4 ± 22.7	20.3 ± 19.3	0.28	small	0.04	-	0.39	small
PP 80%	26.9 ± 42.5	30.1 ± 39.3	21.8 ± 33.2	0.08	-	0.13	-	0.23	small
PP 90%	25.7 ± 35.9	32.5 ± 30.8	17.8 ± 37.3	0.2	small	0.22	small	0.43	small

LP Power 1RM pre

PP 30%	22.1 ± 19.6	35.0 ± 29.9	29.8 ± 23.8	0.51	moderate	0.35	small	0.19	-
PP 40%	24.3 ± 27.1	23.9 ± 17.0	24.6 ± 19.1	0.02	-	0.01	-	0.04	-
PP 50%	24.4 ± 21.3	28.7 ± 16.7	31.3 ± 23.7	0.22	small	0.31	small	0.13	-
PP 60%	26.0 ± 20.3	29.6 ± 15.9	43.5 ± 25.8	0.2	small	0.75	moderate	0.65	moderate
PP 70%	39.4 ± 23.6	33.8 ± 25.1	47.0 ± 14.7	0.23	small	0.39	small	0.64	moderate
PP 80%	45.9 ± 34.3	47.4 ± 32.8	47.6 ± 13.6	0.05	-	0.07	-	0.01	-
PP 90%	57.4 ± 43.2	66.8 ± 40.2	78.9 ± 38.7	0.23	small	0.52	moderate	0.31	small

KE Power 1RM post

PP 30%	12.0 ± 15.7	20.1 ± 14.4	10.4 ± 21.5	0.54	moderate	0.09	-	0.53	moderate
PP 40%	28.4 ± 33.7	21.6 ± 20.6	23.1 ± 18.5	0.24	small	0.15	-	0.08	-
PP 50%	23.0 ± 22.4	9.6 ± 12.9	24.0 ± 23.3	0.73	moderate	0.04	-	0.77	moderate
PP 60%	13.3 ± 14.1	23.6 ± 27.8	24.8 ± 28.5	0.47	moderate	0.51	moderate	0.05	-
PP 70%	16.6 ± 17.3	13.7 ± 20	10.1 ± 16.5	0.16	-	0.39	small	0.2	small
PP 80%	7.7 ± 13.9	21.5 ± 43.7	8.8 ± 21.6	0.43	small	0.06	-	0.37	small
PP 90%	16.0 ± 37.2	12.7 ± 41.6	21.8 ± 50.8	0.08	-	0.13	-	0.2	small

KE Power 1RM pre

PP 30%	22.6 ± 22.9	26.2 ± 20.1	28.4 ± 26.8	0.17	-	0.23	small	0.09	-
PP 40%	35.1 ± 39.0	29.6 ± 17.8	37.6 ± 10.4	0.18	-	0.09	-	0.55	moderate
PP 50%	37.3 ± 25.1	22.6 ± 17.8	39.8 ± 18.8	0.68	moderate	0.11	-	0.94	large
PP 60%	33.7 ± 20.7	32.5 ± 29.7	41.6 ± 22.0	0.05	-	0.37	small	0.35	small
PP 70%	41.0 ± 32.1	21.1 ± 25.5	46.1 ± 24.0	0.69	moderate	0.18		1.01	large
PP 80%	42.5 ± 23.2	51.3 ± 60.8	62.3 ± 28.1	0.19	-	0.77	moderate	0.23	small
PP 90%	67.2 ± 49.7	53.4 ± 47.8	92.4 ± 38.0	0.28	small	0.57	moderate	0.9	large

MID = middle-aged adults; OLD = older adults; LIM = mobility-limited older adults; LP = leg press; KE = knee extension; 1RM = one repetition maximum; RF = rectus femoris; VI = vastus intermedius; VL = vastus lateralis; VM = vastus medialis; MT = muscle thickness; EI = echo intensity. Note: Cohen's d values were classified as suggested by Sullivan & Feinn (2012): 0.2 = small; 0.5 = moderate; 0.8 = large; 1.3 = very large. Values are mean ± SD.

Supplementary Table 4. Complementary analysis comparing mobility-limited older adults pre- and post-training results with those of older adults pre-training.

	OLD pre	LIM pre	LIM post	LIM pre vs. OLD pre			LIM post vs. OLD pre		
				<i>P</i>	Cohen's d		<i>P</i>	Cohen's d	
<i>Dynamic strength</i>									
LP 1RM	145.0 ± 39.9	104.0 ± 35.2	136.3 ± 43.9	0.020	1.061	large	0.621	0.213	small
KE 1RM	37.1 ± 11.2	27.5 ± 7.3	33.3 ± 9.1	0.036	0.941	large	0.401	0.364	small
<i>Isometric strength</i>									
MVIC	26.9 ± 9.8	19.9 ± 6.5	22.8 ± 7.5	0.082	0.789	moderate	0.304	0.456	small
<i>Ultrasound measures</i>									
QUAD MT	64.0 ± 13.2	54.1 ± 10.9	55.2 ± 13.7	0.073	0.796	moderate	0.131	0.664	moderate
<i>Functional capacity</i>									
SPPB	11.4 ± 0.7	7.9 ± 1.1	10.8 ± 1.3	<0.001	4.156	large	0.111	0.704	moderate
30STS	14.8 ± 3.3	11.3 ± 2.1	13.4 ± 2.0	0.010	1.184	large	0.264	0.486	small
MGS	1.97 ± 0.4	1.56 ± 0.2	1.63 ± 0.2	0.013	1.142	large	0.032	0.966	large
TUG	6.4 ± 0.9	8.9 ± 1.9	8.3 ± 1.5	<0.001	2.038	large	<0.001	1.880	large
SC	4.6 ± 0.5	7.0 ± 1.7	6.2 ± 1.6	<0.001	2.500	large	0.001	1.629	large
<i>LP Power 1RM post</i>									
PP 30%	364.9 ± 181.9	186.3 ± 84.2	267.0 ± 129.0	0.015	1.119	large	0.183	0.582	moderate
PP 40%	410.4 ± 196.1	220.3 ± 121.7	293.3 ± 130.3	0.019	1.070	large	0.109	0.708	moderate
PP 50%	425.1 ± 195.2	242.0 ± 146.9	313.7 ± 162.0	0.027	1.004	large	0.172	0.598	moderate
PP 60%	430.8 ± 192.9	250.3 ± 156.2	315.4 ± 144.1	0.029	0.987	large	0.145	0.641	moderate
PP 70%	418.9 ± 185.4	248.6 ± 127.1	300.5 ± 162.7	0.027	0.999	large	0.133	0.661	moderate
PP 80%	381.2 ± 166.5	218.6 ± 98.7	275.4 ± 148.2	0.017	1.085	large	0.136	0.656	moderate
PP 90%	327.6 ± 141.4	192.3 ± 88.0	221.3 ± 96.1	0.020	1.056	large	0.066	0.819	large
<i>LP Power 1RM pre</i>									
PP 30%	-	-	235.5 ± 99.3	-	-	-	0.073	0.797	moderate
PP 40%	-	-	268.3 ± 120.8	-	-	-	0.072	0.800	large
PP 50%	-	-	297.9 ± 132.4	-	-	-	0.108	0.710	moderate
PP 60%	-	-	321.5 ± 145.1	-	-	-	0.166	0.606	moderate
PP 70%	-	-	340.6 ± 170.4	-	-	-	0.319	0.432	small
PP 80%	-	-	324.7 ± 147.4	-	-	-	0.417	0.351	small

PP 90%	-	-	323.5 ± 129.1	-	-	-	0.945	0.030	-
<i>KE Power 1RM post</i>									
PP 30%	338.1 ± 134.1	214.9 ± 78.4	230.5 ± 69.4	0.024	1.022	large	0.044	0.905	large
PP 40%	339.1 ± 148.3	223.9 ± 85.0	266.5 ± 83.6	0.053	0.866	large	0.210	0.547	moderate
PP 50%	368.4 ± 148.8	218.7 ± 77.0	266.1 ± 98.8	0.013	1.135	large	0.090	0.751	moderate
PP 60%	355.8 ± 161.1	223.9 ± 86.9	270.1 ± 98.1	0.041	0.920	large	0.179	0.589	moderate
PP 70%	345.0 ± 133.9	234.9 ± 94.9	253.5 ± 90.1	0.047	0.889	large	0.092	0.746	moderate
PP 80%	309.7 ± 126.1	213.8 ± 91.2	225.8 ± 80.5	0.066	0.819	large	0.098	0.731	moderate
PP 90%	274.0 ± 119.7	165.2 ± 71.2	176.7 ± 56.9	0.026	1.010	large	0.040	0.924	large
<i>KE Power 1RM pre</i>									
PP 30%	-	-	272.4 ± 134.1	-	-	-	0.222	0.533	moderate
PP 40%	-	-	305.3 ± 111.6	-	-	-	0.572	0.244	small
PP 50%	-	-	299.9 ± 99.2	-	-	-	0.248	0.503	moderate
PP 60%	-	-	307.4 ± 98.9	-	-	-	0.441	0.333	small
PP 70%	-	-	337.1 ± 123.1	-	-	-	0.891	0.059	-
PP 80%	-	-	333.1 ± 112.2	-	-	-	0.656	0.192	-
PP 90%	-	-	300.5 ± 101.8	-	-	-	0.593	0.230	small

OLD = *older adults*; LIM = *mobility-limited older adults*; LP = *leg press*; KE = *knee extension*; 1RM = *one repetition maximum*; RF = *rectus femoris*; VI = *vastus intermedius*; VL = *vastus lateralis*; VM = *vastus medialis*; MT = *muscle thickness*; EI = *echo intensity*. Note: Cohen's d values were classified as suggested by Sullivan & Feinn (2012): 0.2 = small; 0.5 = moderate; 0.8 = large; 1.3 = very large. Values are mean ± SD.

Supplementary Table 5. Complementary analysis comparing older adults pre- and post-training results with those of middle-aged adults pre-training.

	MID pre	OLD pre	OLD post	OLD pre vs. MID pre			OLD post vs. MID pre		
				<i>P</i>	Cohen's d		<i>P</i>	Cohen's d	
<i>Dynamic strength</i>									
LP 1RM	189.1 ± 68.9	145.0 ± 40.0	179.2 ± 48.5	0.026	0.790	moderate	0.623	0.168	-
KE 1RM	46.0 ± 17.5	37.1 ± 11.2	41.4 ± 11.5	0.078	0.605	moderate	0.357	0.311	small
<i>Ultrasound measures</i>									
QUAD MT	74.0 ± 11.7	64.0 ± 13.2	66.3 ± 12.3	0.022	0.800	large	0.062	0.644	moderate
QUAD EI	103.1 ± 7.9	109.4 ± 7.0	104.6 ± 7.0	0.016	0.846	large	0.565	0.194	-
<i>Functional capacity</i>									
SPPB	11.9 ± 0.1	11.4 ± 0.7	11.9 ± 0.3	0.001	1.239	large	0.154	0.486	moderate
30STS	18.7 ± 3.4	14.8 ± 3.3	15.8 ± 3.2	0.002	1.146	large	0.012	0.886	large
MGS	2.2 ± 0.4	1.97 ± 0.4	2.02 ± 0.4	0.092	0.579	moderate	0.187	0.449	small
TUG	5.4 ± 0.6	6.4 ± 0.8	6.3 ± 0.9	<0.001	1.310	large	0.001	1.152	large
SC	4.1 ± 0.4	4.6 ± 0.5	4.3 ± 0.6	0.006	0.968	large	0.360	0.309	small
<i>LP Power 1RM post</i>									
PP 30%	586.1 ± 315.1	364.9 ± 181.9	491.5 ± 219.1	0.016	0.874	large	0.313	0.352	small
PP 40%	606.2 ± 321.6	410.4 ± 196.1	510.0 ± 205.4	0.037	0.746	moderate	0.301	0.361	small
PP 50%	624.2 ± 320.7	425.1 ± 195.2	541.1 ± 211.7	0.034	0.761	moderate	0.374	0.310	small
PP 60%	631.3 ± 312.5	430.8 ± 192.9	537.1 ± 207.8	0.029	0.783	moderate	0.303	0.360	small
PP 70%	583.6 ± 292.5	418.9 ± 185.4	514.9 ± 193.7	0.056	0.682	moderate	0.421	0.280	small
PP 80%	527.1 ± 259.3	381.2 ± 166.5	466.2 ± 196.5	0.057	0.678	moderate	0.443	0.267	small
PP 90%	481.7 ± 282.5	327.6 ± 141.4	412.1 ± 160.5	0.049	0.703	moderate	0.377	0.308	small
<i>LP Power 1RM pre</i>									
PP 30%	-	-	484.3 ± 239.7	-	-	-	0.294	0.367	small
PP 40%	-	-	496.7 ± 221.2	-	-	-	0.252	0.401	small
PP 50%	-	-	542.9 ± 256.6	-	-	-	0.418	0.282	small
PP 60%	-	-	550.1 ± 238.1	-	-	-	0.397	0.295	small
PP 70%	-	-	547.6 ± 223.3	-	-	-	0.692	0.139	-
PP 80%	-	-	541.9 ± 213.5	-	-	-	0.859	0.063	-
PP 90%	-	-	527.6 ± 218.4	-	-	-	0.604	0.182	-

KE Power 1RM post

PP 30%	551.7 ± 293.1	338.1 ± 134.1	399.5 ± 152.7	0.008	0.947	large	0.061	0.657	moderate
PP 40%	528.0 ± 306.0	339.1 ± 148.3	409.9 ± 182.4	0.025	0.793	moderate	0.172	0.472	small
PP 50%	547.6 ± 304.2	368.4 ± 148.8	409.2 ± 182.8	0.032	0.755	moderate	0.110	0.555	moderate
PP 60%	543.2 ± 271.3	355.8 ± 161.1	412.9 ± 145.0	0.017	0.846	large	0.083	0.604	moderate
PP 70%	512.0 ± 256.6	345.0 ± 133.9	384.7 ± 147.9	0.021	0.823	large	0.079	0.612	moderate
PP 80%	469.3 ± 233.4	309.7 ± 126.1	345.3 ± 126.1	0.016	0.858	large	0.057	0.667	moderate
PP 90%	389.9 ± 225.6	274.0 ± 119.7	288.1 ± 124.2	0.064	0.647	moderate	0.105	0.563	moderate

KE Power 1RM pre

PP 30%	-	-	426.3 ± 163.4	-	-	-	0.125	0.533	moderate
PP 40%	-	-	437.5 ± 185.8	-	-	-	0.295	0.360	small
PP 50%	-	-	449.4 ± 181.3	-	-	-	0.251	0.395	small
PP 60%	-	-	449.9 ± 175.8	-	-	-	0.233	0.411	small
PP 70%	-	-	446.6 ± 168.5	-	-	-	0.377	0.303	small
PP 80%	-	-	431.5 ± 153.2	-	-	-	0.573	0.193	-
PP 90%	-	-	388.8 ± 140.5	-	-	-	0.987	0.006	-

MID = *middle-aged adults*; OLD = *older adults*; LP = *leg press*; KE = *knee extension*; 1RM = *one repetition maximum*; RF = *rectus femoris*; VI = *vastus intermedius*; VL = *vastus lateralis*; VM = *vastus medialis*; MT = *muscle thickness*; EI = *echo intensity*. Note: Cohen's d values were classified as suggested by Sullivan & Feinn (2012): 0.2 = small; 0.5 = moderate; 0.8 = large; 1.3 = very large. Values are mean ± SD.